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J. Douglas
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Harley R. Myler et al.

Serial No. **09/911,575**

Filing Date: **07/25/2001**

For: **METHOD FOR MONITORING AND AUTOMATICALLY CORRECTING DIGITAL VIDEO QUALITY BY REVERSE FRAME PREDICTION**

Examiner: **TRANG U. TRAN**

Art Unit: **2614**

Attorney Docket No.
32707

Asst. Commissioner for Patents
Alexandria, VA 22313-1450

Sir:

Declaration Under 37 U.S.C. § 1.132 of Michele Van Dyke-Lewis

I, Michele Van Dyke - Lewis, PhD, hereby declare and say as follows:

1. I am a co-inventor in the above-referenced application. I have over 14 years experience in algorithm development and filter design and analysis. I am a founding engineer and Senior Imaging Research Scientist for Teranex, Inc, a leading provider of high-performance platforms that utilize patented array processing technology and target real time, compute intensive applications in the digital media market. Teranex, Assignee for the above reference application, provides products optimized for high quality and performance in format conversion and advanced noise reduction solutions for the broadcast, video and film industries. Currently, I am lead the Image Quality Research Program for Teranex and am a member of the International Telecommunications Union Video Quality Experts Group. I perform filter design and algorithm analysis in support of Teranex products and was a primary architect of Lockheed Martin's sixth generation of parallel processing technology, from which six patents were awarded. Prior to Lockheed, I supported telecom customers and

presented DSP architecture workshops at Texas Instruments. As an assistant professor at the University of Central Florida, I taught courses in digital logic, computer architecture and computer programming. I received B.S. and M.S. degrees in Applied Mathematics and Computer Engineering from the University of Central Florida and Ph.D. in Electrical Engineering, specializing in Digital Signal Processing, from New Mexico State University and currently hold seven US patents.

2. I have read the Office Action dated September 25, 2003, including the Examiner's opinion regarding patentability of claims in the case. Further, I have read and am familiar with the references cited by the Examiner including for U.S. Patent No. 5,745,169 to Murphy and U.S. Patent No. 5, 261,030 to Tanaka used to reject claims in view of what the Examiner believes to be prior art presented in the specification. I believe that the Examiner has misunderstood the teachings in the specification and further has incorrectly used these patent references in rejecting claims to a method and system for correcting errors in digital video as presented in the above referenced application. In response to the comments and perceived understanding of the Examiner, the following statements and factual data are presented in an attempt to clarify matters heretofore presented.

3. To aid the Examiner and readers, consider terms well known in the art for construction:

video -- a sequence of frames or pictures in time, the rate such that when viewed the objects in motion appear fluid. The term is most often used to describe sequences for television. Video may be analog or digital.

sequence -- a set of pictures or frames that constitute either video or a movie. A sequence is sometimes referred to as a stream.

stream -- a series of data, either analog or digital, one or two-dimensional.

picture -- a two-dimensional rendering of a scene at a single moment in time. A picture is sometimes called a still-frame.

frame -- a picture within a video sequence or movie. A frame may be analog or digital.

movie -- a sequence of frames or pictures in time, the rate such that when viewed the objects in motion appear fluid. Movie is a more generic term than video and in this context always refers to digital video.

digital -- data that is sampled in time.

analog -- data that is continuous in time.

sampled -- the process of converting a continuous signal into a digital one. Data values are recorded from a continuous source at regular and sequential time intervals to produce a digital data stream.

continuous -- a signal that changes value with time. Continuous signals are generated by analog video cameras and microphones; the former are two-dimensional (in time) analog video streams while the latter are one-dimensional (in time) audio streams.

cinema -- this term refers to movies or video that are presented in large-scale theater settings to an audience.

cut -- signifies the beginning and end of an intercut sequence. Used in film making to end a scene, as when the director says "cut." In video, a cut occurs when there is a substantial change in the scene content, as when the camera angle changes suddenly or when a blank frame is encountered.

intercut sequence -- the sequence of frames between two cuts.

4. Further, consider Video Quality: The term Video Quality (VQ) generally refers to a subjective opinion derived from human viewers of video or cinema. VQ is typically displayed as a numerical scale and is measured directly using human subjects or indirectly using a computer algorithm that attempts to mimic human evaluation. Human testing is considered to be the "gold standard" against which computer algorithms are measured.

VQ must be distinguished from Quality of Service (QoS) systems. QoS generally speaks to the quality of error detection and correction of communication channels.

Although these channels can degrade video, the VQ process is concerned with observed video at the terminal point of a channel, in other words, what the viewer is seeing.

5. Yet further, consider Video Quality Systems: There are typically three basic types of Video Quality (VQ) systems and each of these types has variations within them. The three types are known as Full-Reference (FR), Reduced-Reference (RR), and No-Reference (NR). Occasionally, an NR system will be referred to as a Zero-Reference system.

A FR-VQ system requires two synchronized video streams, the reference and the processed stream. The reference stream is original video that has not undergone any processing that may have degraded it, the processed stream has had processing applied, possibly a compression of some sort, a format change, passage through a communication channel or some combination of the three. Because of this processing, there is the potential for a degradation of VQ. The FR-VQ system compares the video in the two streams and attempts to detect disparities between the streams. The amount of disparity is then correlated to a change in VQ. VQ systems abound and many different types of algorithms exist to process FR-VQ. A disadvantage of this system is the fact that the original video is required in order to perform the VQ analysis. This means that a FR system can only be used off-line, in a laboratory setting. These systems are used in equipment testing and development and are not useful for point-of-service applications.

A RR-VQ system requires a processed video stream as well as a reduced bandwidth channel (reduced reference) that carries VQ data derived from the original unprocessed video. At the terminal, the processed video is analyzed for quality, again using any number of algorithms designed for this purpose, and the results are compared to the data supplied by the reduced bandwidth channel. The operative concept here is that the original video is analyzed for specific features related to quality. These features, which include far less data than the video itself, are transmitted along with the video. A basic premise is that the reduced bandwidth side channel carrying the VQ features will not degrade the feature data. At the terminal, the video is again

analyzed for VQ and the results compared to the VQ data in the reduced bandwidth channel. If the video channel has not degraded the quality of the video then there will be no difference in the comparison. If degradation has occurred, it will be detected.

NR-VQ system operates solely on the processed video data stream, hence the name: no-reference. In the simplest embodiments of NR-VQ systems, specific degradations that affect video quality are searched for within the video stream. These systems are automatic pattern recognizers and are limited to a set number of degradations--those degradations that they have been programmed to detect. When a specific degradation is detected, an assessment of quality may then be made. If the system has not been programmed for a particular degradation, those degradations will be overlooked.

6. With further reference to the teachings of the above reference application, Reverse Frame Prediction (RFP) is a NR-VQ technique that takes advantage of the similarity between frames within the set of frames that constitute an intercut sequence. RFP uses a cut detector to determine the cuts within a digital video sequence or movie. The cuts partition the video into segments, the intercut sequences. Cuts are detected by computing the two-dimensional correlation between pairs of successive frames. If the correlation is high, typically greater than 0.9, then the two frames are within the same intercut sequence. The intercut sequence frames are then analyzed for VQ using any FR-VQ algorithm. Pairs of frames, or subsets of frames, within the intercut sequence are compared with each other as source and processed video. A fundamental premise of RFP is that the number of high quality frames within the intercut sequence will outnumber those of unacceptable quality. By way of example, if there is little or no difference in quality amongst the frames in the intercut sequence, the VQ of sequence is the average of the VQ between the frames. If a frame or subset of frames within the intercut sequence has a large disparity in VQ from the rest of the sequence, a corrective action may be taken that can include removal or enhancement of bad quality frames or simply a notification that bad VQ frames have been detected.

7. While a cut detector is known to those skilled in the art, and other systems use correlation to determine cuts, the use of the high interframe correlation within intercut sequences to determine VQ using a FR-VQ technique is only taught by the Applicants. The specific FR-VQ technique used is not significant. The specification addresses various FR-VQ methods as potential candidates for RFP and new techniques developed in the future that may also use RFP. Therefore, the concept of RFP would not be obvious to those skilled in the art, as suggested by the Examiner.

8. With regard to comments made by the Examiner in the above referenced Office Action, RFP related claims in the case do claim the intercut sequence (a plurality of highly correlated digital frames), the notion of a FR-VQ technique, and the notion of a NR-VQ technique. The claimed invention is directed to the use of RFP using a FR-VQ technique within an intercut sequence for the purpose of producing a NR-VQ result. Such in neither taught nor suggested in the prior art, nor would it be obvious to persons skilled in the art. I have found that those skilled in the art typically understand a NR-VQ system that does not use a priori information, such as RFP, not to be possible. By way of example and as called for in claim 1, the method includes the step of applying a quality analysis technique to at least two of the plurality of digital video frames to produce at least one video quality metric within one of the at least one intercut sequesce(s). By way of further clarification, and as supported by the specification, RFP does not analyze the intercut sequence for specific degradations as known NR-VQ systems do. Rather, RFP is concerned with comparisons between the frames that constitute the intercut sequence. As suggested by the Examiner, RFP is not a RR-VQ system. No metadata is used by RFP nor is a reduced bandwidth channel used.

9. With regard to Murphy, et al (USPTO #5,745,169):
This patent describes a video error detection system where "An error is identified in a video image by calculating frequency-related coefficients for blocks of the image and considering the statistical distribution of said coefficients." This is distinguished from RFP in that a plurality of frames is not considered. Also, RFP analyzes the entire frame

in comparison to another frame or set of frames. The Murphy patent analyzes the frame in terms of compression blocks. Finally, this patent is concerned with data errors, not VQ.

10. With regard to Tanaka (USPTO #5,251,030):
This patent describes a motion compensation (MC) prediction technique and is not a VQ system. RFP is unconcerned with MC and is not intended for that purpose. RFP employs interframe correlation, as does Tanaka, but not for the same purpose.

11. I hereby declare that all statements made herein of my own accord are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both, under Section 1001 of Title XVIII of the United States Code, and that any such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Michele Van Dyke-Lewis

Michele Van Dyke - Lewis

DATE: February 25, 2004